DOE/DP/00539--052

DE85 002783

NEVADA TEST SITE EXPERIMENTAL FARM: SUMMARY REPORT 1963 - 1981

by

Stuart C. Black and Donald D. Smith
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada 89114

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-AI08-76DP00539

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report has been reviewed by the Environmental Monitoring Systems Laboratory--Las Vegas, U.S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

CONTENTS

	Page
Tables	iv
Summary	1
Introduction	3
Procedures	5
Radioiodine Studies	5
Other Radioisotope Studies	8
Results	10
Radioiodines Studies	10
Other Fission-Products	12
Actinide Studies	13
Discussion	16
References	17
Bibliography	23
Appendix	31

TABLES

Number		Page
1	Experimental Program Variables	6
2	Physical Data for Radioiodine Model	7
3	Actinide Studies in Dairy Animals	14

SUMMARY

The Experimental Farm facility in Area 15 of the Nevada Test Site (NTS) was established in 1963-64 so that the air-forage-cow-milk chain, for the transport of radioiodine, could be investigated. The Farm included an irrigated agricultural area, a dairy-cow herd, milking facilities, and facilities for surgical and necropsy procedures. A later addition was metabolism stalls, developed to facilitate individual collection of urine, feces, milk, and blood from dairy cows. As the research program progressed, radioactive products of the nuclear testing program other than radioiodine were studied in a variety of animals that could be sources of ultimate human exposure.

The studies of radioiodine, other radionuclides, and other animal species that involved the Farm, principally or peripherally, are listed in chronological order in the Appendix. This Appendix is deliberately concise because of its length. Complete data for those experiments for which formal reports were prepared, as indicated for each study, are available in the reports listed in the references.

The radioiodine program was essentially complete by 1970 and was summarized in a 1976 report (reference 48). Table 2 from that report (see pages 7 and 8) indicates the types of studies conducted for that program and the kinds of data collected. Some of the studies were based on exposure from planned or

accidental ventings from nuclear tests and some were based on exposure from artificially generated aerosols labeled with radioiodine.

In addition to its role as an experimental facility for fallout-related metabolism studies, the Farm has been used in cooperative studies with Lawrence Livermore Laboratory, Oak Ridge Associated Universities, and other Environmental Protection Agency (EPA) laboratories. Another important role has been as a staging area for the Animal Investigation Program (AIP). The surgery and necropsy procedures could be performed there in a clean environment and space was available for maintenance of animals and, particularly, for the fistulated steers--known collectively as "Big Sam." It also served as the operation base for the Nevada Applied Ecology Group grazing studies conducted on actinide-contaminated ranges and for ad hoc AIP investigations. Reports on those studies are listed in the enclosed bibliography. The major experimental findings are summarized in the results section of this report.

INTRODUCTION

In 1963 under an Interagency Agreement with the Atomic Energy Commission, the U.S. Public Health Service instituted studies to determine the transport of radioactive iodine in the human food chain. These studies were important because the most immediate hazard to humans who might be exposed to fallout from nuclear tests is radioiodine, which concentrates in the thyroid gland. This is particularly true for infants and young children who drink milk, so elucidation of the air-to-forage-to-cow-to-milk pathway was the primary purpose of the studies. To accomplish this, a dairy farm was established on the Nevada Test Site in Area 15.

The experimental dairy farm was operated in the same manner as a Grade A dairy with dry-lot feeding practices, except that all milk was disposed of as waste. The facilities included up to 26 milk cows; a 15-acre farm plot for growing forage; pens for individually feeding the cows during experiments; metabolism stalls for separate collection of milk, urine, feces and blood; and an abbatoir for sacrifice of experimental animals and collection of tissue samples.

During its 18-year operation, many well-controlled experiments on the milk transfer and metabolism of the radioiodines, other fission products, and the actinides were conducted at the farm. It also served as the base of

operation for the Animal Investigation Program (AIP), which investigated the uptake and retention of radionuclides in a 100-cow beef herd maintained on the Nevada Test Site as well as in other domestic and wild animals both on and off the Nevada Test Site.

This report summarizes the findings of the studies conducted at the farm, lists in chronological order all the major experiments involving the farm, and lists all published reports for both the farm studies and the studies of the Animal Investigation Program.

PROCEDURES

The procedures used in these studies are briefly summarized below; the reports cited in the appendix contain all details of the procedures used for a given experiment. In general, the radioiodine studies were the most complete since measurements were made of the radioiodine concentration in all parts of the air-forage-cow-milk pathway. The other isotopes were administered orally or by injection into the experimental animals and only portions of the pathway were studied. The range of variables studied is listed in Table 1. For example, the kinds of isotopes studied are listed in column 1, the sources for one or more isotopes in column 2, etc. Most isotopes were tested in dairy cows, but some subjects were tested with only a few, e.g., chickens were dosed only with actinides.

RADIOIODINE STUDIES

The Area 15 Dairy Farm was established for these kinds of studies. In general, sized diatomaceous earth aerosols, sprayed salt solution or gaseous iodine, all labeled with iodine-131, were dispersed in air either over growing or chopped fresh forage or over baled or spread hay. When possible, such feedstuff was exposed to fallout from accidental or planned releases from nuclear tests. Weighed amounts of the appropriate feed were fed to lactating cows and the milk produced was measured for total amount and content of radioactivity.

TABLE 1. EXPERIMENTAL PROGRAM VARIABLES

Radio-nuclides	Sources	Subjects	Exposures	Objects
T	Accidental venting	Dairy cows	Forage crops	Milk
Be	Plowshare tests	Steers	Range forage	Urine
Fe	Aerosol Generations:	Calves	Milk	Feces
Rb	Gaseous, aqueous,	Swine	Oral injection	Blood
Te	particulate	Chickens	Intravenous	Eggs
I	Spiked solutions	Goats	injection	Vegetation
Tl		Fish	Inhalation	Organs
W		Plants		Tissues
Pb				
Hg				
U				
Pu				
Np				
Am				
Cm				

In a few instances some cows were exposed to the radioiodine only through inhalation, and fed uncontaminated feed, to estimate the contribution of inhalation to the contamination of milk. In other instances, various chemical forms of radioiodine were placed in capsules and administered to the cows by use of a balling gun to measure milk and tissue distribution following ingestion.

The types of physical data collected from the majority of the radioiodine experiments are shown in Table 2. For the artificial contamination experiments, of course, both the distance from ground zero and the survey-meter readings were not applicable.

TABLE 2. PHYSICAL DATA FOR RADIOIODINE MODEL

Name and Date of Experiment	Cows Per Group	Distance (mi.)	Peak γ-dose Rate[1] (mR/h)	Dose Rate @ 6h (mR/h)	Planch.[2] (μCi/m²)	Air[3] (μCi-s/m³)	F/C[4] Ratio	Particle[5] Size (μm)	Peak Forage Concen. (nCi/kg)	T_{eff} in Forage (days)	Days Fed
Exposure Route:											
Hay:											
Pike	3	84	0.1	0.08					1.3		
03/13/64	3	84	0.06	0.05					0.65		
Palanquin	6	2.85	$2x10^4$	2,300	206	264	3.4		26,000		8
04/14/65	3	3.5	17	2	1.5	3.5	0.11		385		24
TNT	5	1.5	9.0	1.05		ND			5.1	2.4	6
01/12/65	5	0.75	2.9	0.34		ND			1.6	4.0	6
Cabriolet 01/26/68	4	2.8	31	3	1.04	9.92	1.43		68.4	6.2	8
Buggy	4	10	252	25	18.2	52	14.6	0.6	452		
03/12/68	4	10	252	25	18.2	52	14.6	0.6	121		0.5
	4	10	64	6.2	3.1	7.9	6.6	0.6	57	6.8	8
	4	10	64	6.2	3.1	7.9	6.6	0.6	20.7		0.5
Schooner	4	46	100	55	6.43	3.2	6.4	0.6-0.9	56	8.2	10
12/08/68	4	43.5	34	30	1.93	2.0	4.1	0.6-0.9	19	10.5	10
	4	29	14	7	0.39	1.5	13.7	0.6-0.9	4.3	7.9	10
		136	0.58	0.68							
Hayseed 10/04/65	4				3.13	323	4.9	23	405		6
Alfalfa 06/21/66	4				4.66	333	3.5	2	640	6.5	8
Rainout 09/29/66	6				24.6	5.6	0.33	169(drop)	9,800	3.6	7.5
SIP 06/06/67	6				1.63	157	3.2	0.13	79.8		0.5
MICE	6				0.66	132	0.12	gas	2,110	5.9	10.5
09/21/67	6				0.66	132	0.12	gas	102	2.2	3
Green Chop:											
Pike	3	84	0.1	0.08					4.7	5.3	
03/13/64	3	84	0.06	0.05					1.7	5.3	
Palanquin 04/14/65	6	2.85	$2x10^4$	2,300	206	264	3.4		45,400	-	4
Pin Stripe	4	63	1.6	1.1		21.7	3.0		56	4.9	14
04/25/66	6	54	0.38	0.28		6.6	1.9		18	4.0	14
Hayseed	4				3.13	323	4.9	23	1,900	-	4
10/04/65	4				3.13	323	4.9	23	2,700	3.6	6
Alfalfa	4				4.66	334	3.5	2	260	-	3
06/21/66	4				4.66	334	3.5	2	3,400	2.1	9
Rainout 09/29/66	6				24.6	5.6	0.33	169(drop)	21,000	4.5	8
SIP 06/06/67	6				1.63	157	3.2	0.13	1,130	4.1	10
MICE 09/21/67	6				0.66	132	0.12	gas	2,630	4.0	8
HARE	3				1.25	87.5	1.0	0.6	1,030	2.4	5
09/18/68	3				1.43		1.0	0.6	775	3.8	5

(Continued next page)

TABLE 2. (Continued)

Exposure Route: Name and Date of Experiment	Cows Per Group	Distance (mi.)	Peak γ-dose Rate[1] (mR/h)	Dose Rate @ 6h (mR/h)	Planch.[2] (μCi/m²)	Air[3] (μCi-s/m³)	F/C[4] Ratio	Particle[5] Size (μm)	Peak Forage Concen. (nCi/kg)	T_{eff} in Forage (days)	Days Fed
Green Chop:											
Milkrun 08/11/65	8								118 Ci	Capsule	1
Air Uptake:											
Palanquin 04/14/65	4	2.8	$2x10^4$	2,300	206	264	3.4				
Hayseed 10/04/65	4				3.13	323	4.9	23			
Alfalfa 06/21/66	4				4.66	334	3.5	2			
SIP 06/06/67	6				1.63	157	3.2	0.13			
MICE 09/21/67	6				0.66	132	0.12	gas			

1-γ dose-rate measured 3 feet above ground
2-Deposition on planchets
3-Intergrated air concentration
4-Activity on filter divided by activity on charcoal
5-Count median diameter of the aerosol

OTHER RADIOISOTOPE STUDIES

The studies involving the other radioisotopes listed in Table 1 were principally based on oral or intravenous administration to a variety of experimental subjects. The data collected were mostly concerned with excretion of the isotopes in milk, urine, and feces and with their concentration in various tissues. Extensive use of the metabolism stalls of the Experimental Farm facilitated the separate collection of the aforementioned excreta and, frequently, of blood samples.

Some of these studies explored the effect of chemical form on the excretion of radioisotopes, or explored the effect of route of administration. Other

data collected included the differential absorption of plutonium-238 and -239, the transfer of certain actinides to hen's eggs, differential secretion into goat's milk versus cow's milk, uptake in calves from in vivo or in vitro labeled milk, the effect of heating and cooking with labeled natural gas on the tritium exposure of pigs, and the effect of particle size on the passage of ingested soil through the gastro-intestinal tract of cows.

RESULTS

RADIOIODINES STUDIES

The results from these studies, concerned with the air-forage-cow-milk chain, are listed below in the form of statements or equations for various segments of the milk food-chain. The published reports may be consulted for complete details (references: 1-3, 5-11, 13-17, 20-23, 25, 27, 31, 33, 35, 40, 42, 45, 46, 48).

Air to Forage Deposition

The deposition velocity is greater for particulate forms of radioiodine than for I_2. Precipitation appears to increase deposition 2 to 10 times. "Washout" may increase deposition but, if rain continues, it will wash particulates from the vegetation.

Air to Milk Ratio

For estimating maximum milk concentration when the air concentration has been measured, use $nCi/L = 0.8 \times \mu Ci\text{-}s/m^3$ for cows fed fresh forage, or $nCi/L = 0.1 \times \mu Ci\text{-}s/m^3$ for cows fed hay. The term $Ci\text{-}s/m^3$ is the integrated air concentration of radioiodine.

Forage to Milk Relationship

Baled hay contaminated in the open field and fed to cows reduces maximum iodine in milk by a factor of 14 when compared to fresh forage from the same field fed to other cows. Sudan grass feed reduces the maximum milk concentration by a factor of 3 compared to alfalfa feed. Milk concentration can be related to exposure by the following: maximum nCi/L = 4 x mR/hr for fresh forage feed, or = 0.29 x mR/hr for hay feed (G-M survey meter reading at 1 m above ground; maximum or H + 6 hour value, whichever is greater). Iodine uptake from soil by vegetation is negligible for a single acute deposition. Spray irrigation can wash 30-40 percent of iodine particulates off the forage if applied in the first few hours after deposition. The maximum Ci/L milk to maximum Ci/kg feed ratio is 0.07 for cows fed fresh forage and 0.024 for cows fed baled hay contaminated by the same fallout.

Chemical Form of Iodine

There was no difference in secretion of radioiodine in milk following either NaI, I_2, CH_3I, or $NaIO_3$ ingestion by cows.

Inhalation Exposure

Inhalation by the cow during cloud passage increased the milk content of radioiodine by 6 percent if the cow was fed fresh feed and by 30 percent if fed hay.

Isotopes

The 132, 133, and 135 isotopes of iodine in fresh fallout may increase the infant thyroid dose by 38 percent if the milk comes from cows fed fresh forage and by 12 percent if the cows are fed baled hay; if deposition occurs within a few hours after the nuclear test and the consumption of milk begins soon thereafter.

Prediction

For a given cloud content (kt of fission products) the peak milk concentration will be nCi/liter = 17 x (miles from SGZ)$^{-1.32}$ x kt for cows on a pasture which is along the line of maximum fallout.

OTHER FISSION-PRODUCTS

Except for rubidium, the other elements studied were secreted in milk to a much smaller extent than were the radioiodines. In these studies, the cows were placed in metabolism stalls and the radioisotope, contained in a gelatin capsule, was administered orally.

Over 8 to 10 days the total percent dose secreted in cow milk following a single oral intake was:

for ^{86}Rb - 15% (c.f. only 8 to 9% of ingested iodine)(reference 30);

for ^{202}Tl - 2.5% (reference 19);

for ^{7}Be, ^{59}Fe, ^{182}W, ^{202}Hg, ^{203}Pb, and ^{129}Te - less than 0.5% (references 18, 19, 28, 36, 39, 49).

ACTINIDE STUDIES

In these studies the actinides were administered to lactating animals by either oral or intravenous injection. The animals were confined in metabolism stalls for 6 to 8 days for separate collection of excreta and were later sacrified so that tissue concentrations could be measured. Table 3 contains a summary of the results (references 43-45, 51-61).

Dairy Animals

In cows, the highest percent dose absorbed for the ingested actinides was 0.025 percent for plutonium nitrate, but only 2×10^{-4} percent was transferred to milk. About 4×10^{-4} percent of ingested americium or curium chloride was transferred to milk. For edible tissues, the maximum concentration in liver was 7×10^{-4} percent dose per kg and in muscle was 4×10^{-6} percent dose per kg following oral intake of curium chloride. The concentration in liver and muscle was about 2,000 times higher following intravenous injection compared to oral administration for the soluble form of the actinides.

In goats, the highest percent dose absorbed was 0.5 percent for ingested neptunium and 0.01 percent of that dose appeared in milk. In edible tissues, neptunium was also highest of the actinides with maximum percent oral dose being 0.015/kg for liver and 5×10^{-4}/kg for muscle. A difference between cows

TABLE 3. ACTINIDE STUDIES IN DAIRY ANIMALS*

Animal	chemical	Mode of Intake	Percent Uptake	Concentration in Edible Tissue-%/kg Liver	Muscle	% Transfer to Milk
Cow	^{238}Pu oxide	oral**	0.003	5×10^{-5}	3×10^{-7}	2×10^{-5}
Cow	^{238}Pu nitrate	oral	0.025	3×10^{-4}	4×10^{-6}	2×10^{-4}
Cow	^{238}Pu nitrate	i.v.	-	3×10^{-4}	4×10^{-6}	1.6
Goat	^{238}Pu nitrate	i.v.	-	-	-	0.42
Cow	^{241}Am nitrate	oral	0.014	4×10^{-4}	4×10^{-6}	4×10^{-4}
Goat	^{241}Am nitrate	oral	0.014	0.008	4×10^{-5}	0.004
Cow	^{241}Am nitrate	i.v.	-	3.8	0.019	2.7
Goat	^{241}Am nitrate	i.v.	-	57	0.29	2.0
Cow	^{243}Cu chloride	oral	0.02	7×10^{-4}	4×10^{-6}	4×10^{-4}
Goat	^{243}Cu chloride	oral	0.006	0.002	1×10^{-4}	2×10^{-4}
Cow	^{243}Cu chloride	i.v.	-	2.5	0.009	2.0
Goat	^{243}Cu chloride	i.v.	-	42	0.27	2.0
Goat	^{234}Np chloride	oral	0.48	0.015	5×10^{-4}	0.01
Goat	^{234}Np chloride	i.v.	-	5.1	0.033	0.24

*Milk collected for 4 to 10 days after dosing and the animals sacrificed a few days later.

**The cows in this group received a daily oral dose of ^{238}Pu dioxide for 19 days. All other animals received a single dose.

and goats is suggested by the high percentage uptake of americium and curium in the goat liver following i.v. injection of the radioisotopes.

The studies summarized above, other than radioiodine studies, were conducted by use of oral or intravenous administration of the nuclides; no aerosol generation for contamination of forage crops was attempted.

In studies of actinide transfer to hen eggs, the isotope was detectable only in the yolk. For chickens given daily oral doses of plutonium-238 or americium-241, the peak concentration in egg yolk, as a percentage of the total dose, was 1.2×10^{-5} percent for plutonium oxide and 3×10^{-3} percent for both plutonium citrate and americium citrate.

Studies of plutonium oxide uptake by alfalfa plants indicated about 50 times as much of the 238 isotope compared to the 239 isotope was taken up. However, in dairy cows there was little difference between the two plutonium isotopes as far as milk secretion and tissue concentration were concerned when the isotopes were given orally.

CONCLUSION

The Experimental Farm was a unique facility essential to the types of studies conducted thereon. The location and facilities permitted experiments using types and/or quantities of materials that would have been extremely difficult, if not impossible, to use elsewhere. The experimental design with dry-lot feeding practices and sophisticated collection and analysis techniques yielded more accurate data on radionuclide metabolism and tissue distribution than would have been possible with other experimental regimes.

The experiments conducted with the Farm as a base, and the AIP related activities, have generated over 100 formal reports and published presentations as indicated in the references and bibliography. These reports should be consulted to determine the detailed procedures and actual data used to derive the conclusions summarized above. The appendix to this report gives, in abstract, the purpose, design, and findings of each of the experiments conducted at the farm and references the published report, if available, from which the data were abstracted.

The findings from the radioisotope studies at the Experimental Dairy Farm and the results obtained from the Animal Investigation Program provide a rationale for making predictions and for planning protective actions that could be useful in emergency response to accidental contaminating events where fresh fission products are involved. The factors listed in the Results section above can provide preliminary information pending more complete analyses as times becomes available.

REFERENCES CITED IN TEXT OR APPENDIX

1. Barth, Delbert S., and Veater, Joel G. Dairy Farm Radioiodine Study Following the Pike Event. SWRHL-14r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 24 pp., 1964. (Also Report No. TID-21764)

2. Barth, D. S., and Seal, M. S. "Radioiodine Transport Through the Ecosystem, Air-Forage-Cow-Milk Using a Synthetic Dry Aerosol." pp. 151-158. Radioecological Concentration Processes, Proceedings of an International Symposium Held in Stockholm 25-29 April, 1966.

3. Bioenvironmental Research Program. Radioiodine Study in Conjunction with Project Sulky. SWRHL-29R. U.S. Public Health Service. Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 42 pp., 1966.

4. Hazzard, D. G., Withrow, T. J., and Bruckner, G. H., "Verxite Flakes for In Vivo Binding of ^{134}Cs in Cows." J. Dairy Science Vol. 50, No. 6, p. 992, June 1967.

5. Douglas, Richard L. "Health Physics Program at the Nevada Test Site Experimental Farm." Presented at the Health Physics Society Mid-Year Tropical Symposium, Los Angeles, California, January 28-31, 9 pp., 1969.

6. Black, S. C., Barth, D. S., Engel, R. E., and Falter, K. H. Radioiodine Studies Following the Transient Nuclear Test (TNT) of a KIWI Reactor. SWRHL-26r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 92 pp., 1969.

7. Douglas, Richard L. "Radioiodine Transport through the Air-Forage-Cow-Milk System Using a Gaseous $^{131}I_2$ Contaminant (Project Mice)." Presented at 14th Annual Health Physics Society Meeting, Pittsburgh, Pennsylvania, June 8-12, 1969.

8. Barth, D. S., Engel, R. E., Black, S. C., and Shimoda, W. Dairy Farm Radioiodine Studies Following the Pin Stripe Event of April 25, 1966. SWRHL-41r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 72 pp., 1969.

9. Stanley, Richard E., Black, Stuart C., and Barth, Delbert S. ^{131}I Dairy Cow Studies Using a Dry Aerosol (Project Alfalfa). SWRHL-42r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 75 pp., 1969.

10. James, R. H., McNelis, D. N., Whittaker, E. L., and Kennedy, N. C. Aerosol Preparation, Generation, and Assessment (Project Hare). SWRHL-75r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 22 pp., 1970.

11. Shimoda, W., Black, S. C., Falter, K. H., Engel, R. E., and Barth, D. S. Study of a Single Dose ^{131}I - ^{126}I Ratio in Dairy Cows. SWRHL-27r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 100 pp., 1970.

12. Douglas, Richard L., Mason, Benjamin J., and Moghissi, A. Alan. "Variations in Tritium Concentrations in Urine of Employees at the Nevada Test Site Experimental Farm." Presented at the Health Physics Society 15th Annual Meeting, Chicago, Illinois, June 28-July 2, 1970.

13. McFarlane, James C., and Mason, Benjamin J. Plant Radioiodine Relationships--A Review. SWRHL-90r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 50 pp., 1970.

14. McNelis, D. N., Black, S. C., and Whittaker, E. L. Radioiodine Field Studies with Synthetic Aerosols. SWRHL-103r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 23 pp., 1971.

15. Mason, Benjamin J., Black, Stuart C., and Barth, Delbert S. ^{131}I, Dairy Cow Uptake Studies Using a Submicrometer Dry Aerosol. SWRHL-39r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 31 pp., 1971.

16. Douglas, Richard L., Black, Stuart C., and Barth, Delbert S. ^{131}I Transport through the Air-Forage-Cow-Milk System Using an Aerosol Mist (Project Rainout). SWRHL-43r. U.S. Environmental Protection Agency, Las Vegas, Nevada. 38 pp., 1971.

17. White, Mary Mayes, and Moghissi, A. A. "Transfer of ^{131}I from Milk into Cheese." Health Physics Vol. 21, pp. 116-118, July 1971.

18. Stanley, R. E., Mullen, A. A., and Bretthauer, E. W. "Transfer to Milk of Ingested Radiolead." Health Physics Vol. 21, pp. 211-215, August 1971.

19. Mullen, A. L., Stanley, R. E., Black, S. C., and Moghissi, A. A.: "Dairy Cow Absorption and Milk Secretion of Four Radionuclides." Presented at Health Physics Society 16th Annual Meeting, New York, New York. July 1971.

20. Douglas, Richard L., Payne, James G., Jr., Mullen, Anita L., and Moghissi, A. Alan. "Health Physics Aspects of Large-Animal Radioisosotope Studies." Presented at Radiation Safety Officers Conference, Purdue University, September 23-24, 1971.

21. Potter, G. D., and Black, S. C.. "Secretion of Fallout Radionuclides in Milk." Presented at workshop on Survival of Agriculture in the Event of Nuclear War, Front Royal, Virginia, October 12, 1971.

22. Black, Stuart C., Bretthauer, Erich W., and McNelis, David N. Radionuclide Studies with Dairy Cows Following Two Plowshare Experiments. SWRHL-85r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 32 pp., 1971.

23. Black, Stuart C., Engel, Ronald E., Randecker, Victor W., and Barth, Delbert S. Radioiodine Studies in Dairy Cows Following Project Palanquin. PNE-914F. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 60 pp., 1971.

24. Moghissi, A. A., Patzer, R. G., McNelis, D. N., and Carter, M. W. "Background Information for the Development of a Radiation Standard for Tritium in Nuclear Stimulated Natural Gas." Presented at the Sixth Annual Health Physics Society Topical Symposium, Richland, Washington, November 2-5, 1971.

25. Black, Stuart C., McNelis, David N., and Bretthauer, Erich W. Radionuclide Studies in Dairy Cows Following Project Schooner. SWRHL-112r. U.S. Public Health Service, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 26 pp., 1972.

26. McNelis, D. N., Moghissi, A. A., Patzer, R. G., and McMillan, R. C. "Tritium Body Burden of Swine Following the Rupture of a Luminous Source Activated with Elemental Tritium." Health Physics Vol. 22, pp. 161-164, February 1972.

27. Bretthauer, E. W., Mullen, A. L., and Moghissi, A. A. "Milk Transfer Comparisons of Different Chemical Forms of Radioiodine." Health Physics Vol. 22, pp. 257-260, March 1972.

28. Mullen, A. L., Stanley, R. E., Lloyd, S. R., and Moghissi, A. A. "Radioberyllium Metabolism by the Dairy Cow." Health Physics Vol. 22, pp. 17-22, January 1972.

29. Patzer, Robert G., Moghissi, A. Alan, and McNelis, David N. "Tritium Transfer to Swine from Tritiated Natural Gas Used for Domestic Heating and Cooking." Presented at the Health Physics Society meeting, Las Vegas, June 12-16, 1972.

30. Mullen, A. L., Stanley, R. E., and Moghissi, A. A. "Absorption, Distribution and Milk Secretion of Radionuclides by the Dairy Cow--II. Radiorubidium." Health Physics Vol. 24, pp. 417-422, April 1973.

31. Brown, K. W., and McFarlane, James C. "Deposition and Retention of ^{131}I on Grayia Spinosa Following Baneberry." Health Physics Vol. 24, pp. 680-682, June 1973.

32. Stanley, Richard E., Bretthauer, Erich W., and Sutton, William W. Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle. NVO-142. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nevada. pp. 163-185, 1974.

33. Barth, Julius, Whittaker, Earl L., and Barth, Delbert S. The Behavior of ^{131}I in an Artificial Rumen and in the Simulated Fluids of the Abomasum and Intestine. NERC-LV-539-32. U.S. Environmental Protection Agency, Las Vegas, Nevada. 8 pp., 1974.

34. Beckert, W. F., Moghissi, A. A., Au, F. H. F., Bretthauer, E. W., and McFarlane, J. C. "Formation of Methylmercury in a Terrestrial Environment." Nature Vol. 249, pp. 674-675, June 1974.

35. Mason, B. J., Brown, K. W., Hop, H. W., and McFarlane, J. C. Retention of Elemental and Particulate Radioiodine on Alfalfa. NERC-LV-539-33. U.S. Environmental Protection Agency, Las Vegas, Nevada. 17 pp., 1974.

36. Mullen, Anita A., and Stanley, Richard E. "Absorption, Distribution, and Milk Secretion of Radionuclides by the Dairy Cow III: Radiotellurium." Health Physics Vol. 27, pp. 279-284, September 1974.

37. Stanley, R. E., Bretthauer, E. W., and Sutton, W. W. Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle. NVO-153. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. pp. 97-124, 1975.

38. McFarlane, J. C., Brown, K. W., and Kinnison, R. R. "In Situ Soil Gamma Analyzer--A New Approach to Determine the Movement of Pollutants in Soils." Soil Science Vol. 120, No. 2, pp. 140-146, February 1974.

39. Mullen, A. L., Stanley, R. E., Lloyd, S. R., and Moghissi, A. A. "Absorption, Distribution, and Milk Secretion of Radionuclides by the Dairy Cow IV. Inorganic Radiomercury." Health Physics Vol. 28, pp. 685-691, June 1975.

40. Black, S. C., Stanley, R. E., Barth, D. S. ^{131}I Levels in Cow's Milk Following Ingestion of Contaminated Alfalfa or Sudan Grass. EMSL-LV-539-1. U.S. Environmental Protection Agency, Las Vegas, Nevada. 22 pp., 1975.

41. Shuyler, L. R., Clark, D. A., Barth, J., and Smith, D. D. "Excretion of Salts by Feedlot Cattle in Response to Variations in Concentrations of Sodium Chloride Added to Their Ration." Proceedings of 3rd International Symposium on Livestock Wastes--1975. Presented at the University of Illinois, Urbana-Champaign, Illinois, April 21-24, 1975.

42. Smith, D. D., Black, S. C., Giles, K. R., and Moghissi, A. A. Report of Animal Investigation Program Activities for the Baneberry Event. NERC-LV-539-10. U.S. Environmental Protection Agency, Las Vegas, Nevada. 55 pp., 1975.

43. Mullen, Anita A., Lloyd, S. R., and Mosley, R. E. "Distribution of Ingested Transuranium Nuclides in Chickens and Subsequent Transport to Eggs." Proceedings of the Symposium on Transuranium Nuclides in the Environment Organized by the United States Energy Research and Development Administration and the International Atomic Energy Agency. Presented in San Francisco, November 17-21, 1975 (pp. 423-433).

44. Beckert, W. F., and Au, F. H. F. "Plutonium Uptake by a Soil Fungus and Transport to its Spores." Proceedings of the Symposium on Transuranium Nuclides in the Environment Organized by the United States Energy Research and Development Administration and the International Atomic Energy Agency. Presented in San Francisco, November 17-21, 1975 (pp. 337-345).

45. Smith, D. D., Barth, J., and Patzer, R. G. "Grazing Studies on a Plutonium-Contaminated Range of the Nevada Test Site." Proceedings of the Symposium on Transuranium Nuclides in the Environment Organized by the United States Energy Research and Development Administration and the International Atomic Energy Agency. Presented in San Francisco, November 17-21, 1975 (pp. 325-336).

46. Black, S. C., Douglas, R. L., and Barth, D. S. Gaseous Radioiodine Transport in the Air-Forage-Cow-Milk System. EMSL-LV-539-2. U.S. Environmental Protection Agency, Las Vegas, Nevada. 24 pp., 1976.

47. Patzer, R. G., Potter, G. D., and Sutton, W. W. Passage of Sand Particles through the Gastrointestinal Tract of Dairy Cows. NVO-159. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. pp. 47-46, 1976.

48. Black, Stuart C., and Barth, Delbert S. Radioiodine Prediction Model for Nuclear Tests. EPA-600/4-76-027. U.S. Environmental Protection Agency, Las Vegas, Nevada. 38 pp., 1976.

49. Mullen, A. L. Bretthauer, E. W., and Stanley, R. E. "Absorption, Distribution, and Milk Secretion of Radionuclides by the Dairy Cow--V. Radiotungsten." Health Physics Vol. 31, pp. 417-424, November 1976.

50. Mullen, A. L., Moghissi, A. A., Wawerna, J. C., Mitchell, B. A., Bretthauer, E. W., and Stanley, R. E. Tritium Retention by Cows and Steers and Transfer to Milk. EPA-600/3-77-076. U.S. Environmental Protection Agency, Las Vegas, Nevada. 16 pp., 1977.

51. Sutton, W. W., Patzer, R. G., Hahn, P. B., and Potter, G. D. Bovine Transport and Retention of Plutonium-238 with Special Emphasis on the Gastrointestinal Uptake of In Vivo Labeled Milk. NVO-171. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. pp. 179-192. 1977.

52. Sutton, W. W., and Mullen, A. A. "Transport of Plutonium Via Food Products of Animal Origin," in Transuranics in Natural Environments. NVO-178. U.S. Energy Research and Development Administration, Las Vegas, Nevada. pp. 435-448, 1977.

53. Patzer, R. G., Sutton, W. W., Hahn, P. B., and Potter, G. D. Comparisons of Curium-243 and Plutonium-238 Biological Transport in Dairy Animals Following Intravenous Injection. NVO-181. U.S. Environmental Protection Agency, Las Vegas, Nevada. pp. 243-265, 1977.

54. Sutton, W. W., Patzer, R. G., Hahn, P. B., and Potter, G. D., "Plutonium Retention in Dairy Calves Following Ingestion of Either In Vivo Labeled or In Vitro Labeled Milk Transuranics in Desert Ecosystems." NVO-181. U.S. Department of Energy, Las Vegas, Nevada. pp. 229-241, 1977.

55. Sutton, W. W.., Patzer, R. G., Mullen, A. A., Hahn, P. B., and Potter, G. D. Metabolism of Americium-241 in Dairy Animals. EMSL-LV-0539-22. U.S. Environmental Protection Agency, Las Vegas, Nevada. 24 pp., 1978.

56. Brown, Kenneth W. Plutonium-239 and Americium-241 Uptake by Plants from Soil. EPA-600/3-79-026. U.S. Environmental Protection Agency, Las Vegas, Nevada. 16 pp., 1979.

57. Sutton, W. W., Patzer, R. G., Hahn, P. B., and Potter, G. D. Biological Transport of Curium-243 in Dairy Animals. EMSL-LV-0539-23. U.S. Environmental Protection Agency, Las Vegas, Nevada. 23 pp., 1979.

58. Patzer, R. G., Mullen, A. A., Sutton, W. W., Potter, G. D., Mosley, R. E., and Efurd, D. W. Plutonium-238 and Plutonium-39 Metabolism in Dairy Cows Following Ingesting of Mixed Oxides. EPA-600/3-80-097. U.S. Environmental Protection Agency, Las Vegas, Nevada. 31 pp., 1980.

59. Mullen, A. A., Lloyd, S. R., Mosley, R. E., Potter, G. D., and Patzer, R. G. Absorption, Distribution, and Milk Secretion of Neptunium in the Dairy Goat. NVO-181. U.S. Department of Energy, Las Vegas, Nevada. pp. 267-279, 1977.

60. Mullen, A. A., Mosley, R. E., and Potter, G. D. "Tissue Distribution of Soilborne Aged Radionuclides Following Ingestion by Goats." To be published.

61. Sutton, W. W., Patzer, R. G., and Potter, G. D. Biotransport of Transuranium Radionuclides in Dairy Animals: A Data Summary. EMSL-LV-0539-35. U.S. Environmental Protection Agency, Las Vegas, Nevada. 53 pp., 1979.

AIP BIBLIOGRAPHY

Farmer, G. R. "Effects of Radioactive Fall-Out on Bighorn." pp. 15-19. Desert Bighorn Council 1959 Transactions. 86 pp. 1959.

Farmer, G. R. Off-Site Animal Investigation Project. Second Annual Report. The Special Services Division of Reynolds Electrical and Engineering Co., Inc. Contract AT(29-2)-162. 19pp. June 30, 1959.

Farmer, G. R. "Radioactivity in Bighorn Sheep." pp. 23-25. Desert Bighorn Council 1960 Transactions. 107 pp. 1960.

Fountain, E. L. "Fallout, Its Relation to Wildlife." pp. 95-97. Desert Bighorn Council 1961 Transactions. 119 pp. 1961.

Fountain, E. L. Off-Site Animal Investigation Project. Fourth Annual Report. Reynolds Electrical and Engineering Co., Inc. Contract AT(29-2)-162. 32 pp. June 30, 1961.

Fountain, E. L. "Nuclear Test Program as It Affects Bighorn Sheep." pp. 87-92. Desert Bighorn Council 1962 Transactions. 130 pp. 1962.

Fountain, E. L. "Biological Assays." pp. 53-57. Desert Bighorn Council 1963 Transaction. 202 pp. 1963.

Blincoe, C., V. R. Bohman, and E. L. Fountain. "Iodine-131 in bovine thyroid glands from 1957 through 1961." J. Agr. and Food Chem. 12:5, pp. 414-418. 1964.

Engel, R. E. "Methods of Post Mortem Description of Wildlife Ruminants with Two Commonly Observed Lesions in the Desert Bighorn Sheep." pp. 68-69b. Desert Bighorn Council 1965 Transactions. 92 pp. 1965.

Kramp, R. C. "Preliminary Report on ^{90}Sr Levels in Hock Joints of Desert Bighorn Sheep and Mule Deer." pp. 62-67. Desert Bighorn Council 1965 Transactions. 92 pp. 1965.

Blincoe, C., V. R. Bohman, and E. L. Fountain. "Cesium-137 concentrations in desert range cattle." J. Agr. and Food Chem. 13:2, p. 157. 1966.

Bohman, V. R., C. Blincoe, M. A. Wade, A. L. Lesperance, and E. L. Fountain. "Accumulation of strontium in bovine bones." J. Agr. and Food Chem. 14:4, pp. 413-415. 1966.

Brown, K. W. and D. D. Smith. The Poisonous Plants of the U.S. Atomic Energy Commission's Nevada Test Site, Nye County, Nevada. SWRHL-33r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 56 pp. 1966.

Bohman, V. R. and A. L. Lesperance. The Accumulation of Fission Products in Bovine Tissues and An Evaluation of Certain Factors Influencing the Uptake of Materials. Annual Report 1967. U.S. Department of Health, Education, and Welfare. Southwestern Radiological Health Laboratory, Las Vegas, Nevada. Contract AT(04-3)-509. 28 pp. 1967.

Brechbill, R. A., R. E. Engel, and R. C. Kramp. Calcium in Hock Joints of Wildlife Ruminants in Selected Areas of the United States. SWRHL-34r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 8 pp. 1967.

Douglas, R. L. Status of the Nevada Test Site Experimental Farm. SWRHL-36r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 30 pp. 1967.

Fountain, E. L. and M. S. Seal. "Strontium-90 in the bones of big game in the Western United States." Health Phys. 13 pp. 1205-1209. November 1967.

Brown, K. W. and B. J. Mason. Range Survey, Area 18, Nevada Test Site. SWRHL-52. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 42 pp. 1968.

Cohen, S. L. "Amputation of the Forelimb of a Desert Bighorn Sheep." pp. 28-37. Desert Bighorn Council 1968 Transactions. 77 pp. 1968.

Engel, R. E. and S. L. Cohen. Principles of Reporting Post-Mortem Findings. SWRHL-35r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 15 pp. 1968.

Hull, B. P. and S. L. Cohen. Animal Investigation Program Baseline Studies: Supplemental Test Site "C". SWRHL-54r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 14 pp. 1968.

Smith, T. M., A. L. Lesperance, V. R. Bohman, R. A. Brechbill, and K. W. Brown. "Intake and digestibility of forages grazed by cattle on a southern Nevada range." Proceedings, Western Section, American Society of Animal Science 19 pp. 277-282. 1968.

Brechbill, R. A. Special Bovine Sampling Study--Project Roller Coaster Sites. SWRHL-53r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 23 pp. June 1969.

Daley, E. M. and D. D. Smith. Agronomic Aspects of the Experimental Dairy Farm. SWRHL-63r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 41 pp. 1969.

Smith, D. D. and R. E. Engel. Progress Report for the Bioenvironmental Research May 22, 1964 through July 1, 1966. Part I. Experimental Dairy Herd. SWRHL-55r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 106 pp. 1969.

Helvie, J. B. and D. D. Smith. "Summary of Necropsy Findings in Desert Bighorn Sheep." pp. 28-42. Desert Bighorn Council 1970 Transactions. 200 pp. 1970.

Leavitt, V. D. Soil Survey of Area 18, Nevada Test Site. SWRHL-74r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 119 pp. 1970.

Smith, D. D. Status of the Bioenvironmental Research Experimental Dairy Herd. July 1, 1966 through December 31, 1968. SWRHL-67r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 90 pp. 1970.

Smith, D. D. Management History of the AEC Beef Herd 1 June 1964 - 1 June 1969. SWRHL-80r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 26 pp. 1970.

Smith, D. D. and K. R. Giles. Animal Investigation Program 1969 Annual Report. SWRHL-102r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Laboratory, Las Vegas, Nevada. 20 pp. 1970.

Daley, E. M. Agronomic Aspects of the Experimental Dairy Farm During 1969. SWRHL-104r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 19 pp. 1971.

Western Environmental Research Laboratory. The January 1971 Sheep Death Incident Near Garrison, Utah. SWRHL-114r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 11 pp. 1971.

Daley, E. M. Agronomic Aspects of the Experimental Dairy Farm - 1970. SWRHL-117r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 18 pp. 1972.

Klein, W. L. and R. A. Brechbill. Preliminary Radiation Surveillance on An Aquatic System Near the Nevada Test Site June - July 1967. SWRHL-65r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 23 pp. 1972.

Smith, D. D. "Radiation Surveillance of Ruminants On and About the Nevada Test Site." pp. 101-108. Desert Bighorn Council 1971 Transactions. 110 pp. 1971. Also, NERC-LV-539-18. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 10 pp. 1972.

Smith, D. D., K. W. Brown, R. A. Brechbill, K. R. Giles, and A. L. Lesperance. The Radionuclide Concentrations and Botanical Composition of the Diet of Cattle Grazing the Area 18 Range of the Nevada Test Site, 1966-1970. SWRHL-110r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 31 pp. 1972.

Smith, D. D. Status of the Environmental Protection Agency's Nevada Test Site Experimental Dairy Herd January 1, 1969 - December 31, 1970. NERC-LV-539-22. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 62 pp. 1973.

Smith, D. D. Observations on Wildlife and Domestic Animals Exposed to the Ground Motion Effects of Underground Nuclear Detonations. NERC-LV-539-24. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 11 pp. 1973.

Smith, D. D. and K. R. Giles. Report of Bioenvironmental Sampling at the Gnome Site, Carlsbad, New Mexico - October 1972. NERC-LV-539-25. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 35 pp. 1973.

Smith, D. D. "Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada." pp. 151-161. The Dynamics of Plutonium in Desert Environments. Nevada Applied Ecology Group Progress Report, July 1974. NVO-142. P. B. Dunaway and M. G. White, eds. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nevada. 369 pp. 1974.

Smith, D. D. and K. R. Giles. Animal Investigation Program 1970 Annual Report. NERC-LV-539-16. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 53 pp. 1974.

Shuyler, L. R., D. D. Smith, D. A. Clark, and J. Barth. "Excretion of Salts by Feedlot Cattle in Response to Variations in Concentrations of Sodium Chloride Added to Their Ration." pp. 336-343. Managing Livestock Wastes. Third International Symposium on Livestock Wastes--1975. PROC-275. 1975.

Smith, D. D. "Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada." pp. 125-135. The Radioecology of Plutonium and Other Transuranics in Desert Environments. Nevada Applied Ecology Group Progress Report, June 1975. NVO-153. M. G. White and P. B. Dunaway, eds. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. 503 pp. 1975.

Smith, D. D. and S. C. Black. Actinide Concentrations in Tissues from Cattle Grazing Near the Rocky Flats Plant. NERC-LV-539-36. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 47 pp. 1975.

Smith, D. D. and K. R. Giles. 1971 Animal Investigation Program Annual Report. NERC-LV-539-20. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 39 pp. 1975.

Brown, K. W., D. D. Smith, D. E. Bernhardt, K. R. Giles, and J. B. Helvie. "Food Habits and Radionuclide Tissue Concentrations of Nevada Desert Bighorn Sheep 1972-1973." pp. 61-68. Desert Bighorn Council 1975 Transactions. 72 pp. 1976. Also, EMSL-LV-539-6. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 23 pp. 1976.

Daley, E. M. Agronomic Practices of the Nevada Test Site Experimental Dairy Farm During 1971, 1972, and 1973. EMSL-LV-539-5. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 25 pp. 1976.

Giles, K. R. Springs on the Nevada Test Site and Their Use by Wildlife. NERC-LV-539-26. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 15 pp. 1976.

Smith, D. D. "Status Report on Grazing Studies on a Plutonium-Contaminated Range of the Nevada Test Site." pp. 41-45. Studies of Environmental Plutonium and Other Transuranics in Desert Ecosystems. NVO-159. M. G. White and P. B. Dunaway, eds. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. 189 pp. 1976.

Smith, D. D., J. Barth, and R. G. Patzer. "Grazing Studies on a Plutonium-Contaminated Range of the Nevada Test Site." pp. 325-336. Proceedings of the Symposium on Transuranium Nuclides in the Environment. IAEA-SM-199/73. San Francisco, California, November 17-21, 1975. 724 pp. 1976.

Smith, D. D., S. C. Black, K. R. Giles, D. E. Bernhardt, and R. R. Kinnison. Tissue Burdens of Selected Radionuclides in Beef Cattle On and Around the Nevada Test Site. NERC-LV-539-29. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 83 pp. 1976.

Smith, D. D., K. R. Giles, and D. E. Bernhardt. Animal Investigation Program 1972 Annual Report. NERC-LV-539-35. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 82 pp. 1976.

Daley, E. M. Five-Year Summary Report of an Experimental Dairy Herd Maintained on the Nevada Test Site 1971 through 1975. EMSL-LV-0539-9. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 45 pp. 1977.

Gilbert, R. O., D. D. Smith, and L. L. Eberhardt. "An Initial Synthesis of Area 13 ^{239}Pu Data and Other Statistical Analyses." pp. 237-274. Environmental Plutonium on the Nevada Test Site and Environs. NVO-171. M. G. White, P. B. Dunaway, and W. A. Howard, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 322 pp. 1977.

Smith, D. D. "Grazing Studies on a Contaminated Range of the Nevada Test Site." pp. 139-149. Environmental Plutonium on the Nevada Test Site and Environs. NVO-171. M. G. White, P. B. Dunaway, and W. A. Howard, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 322 pp. 1977.

Smith, D. D. "Review of Grazing Studies on Plutonium-Contaminated Rangelands." pp. 407-417. Transuranics in Natural Environments. NVO-178. M. G. White and P. B. Dunaway, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 710 pp. 1977.

Smith, D. D. ^{129}I in Animal Thyroids from Nevada and Other Western States. EPA-600/3-77-067. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 22 pp. 1977.

Smith, D. D. and D. E. Bernhardt. "Actinide Concentrations in Tissues from Cattle Grazing a Contaminated Range." pp. 281-303. Transuranics in Desert Ecosystems. NVO-181. M. G. White, P. B. Dunnaway and D. L. Wireman, eds. Nevada Applied Ecology Group, U. S. Department of Energy, Las Vegas, Nevada. 469 pp. 1977.

Smith, D. D., K. R. Giles, and D. E. Bernhardt. Animal Investigation Program 1973 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-3. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 89 pp. 1977.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1974 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-10. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 95 pp. 1977.

Brown, K. W., D. D. Smith, and R. P. McQuivey. "Food Habits of Desert Bighorn Sheep in Nevada 1957-1975." Desert Bighorn Council 1976 Transactions. 1978.

Daley, E. M. Status Report of an Experimental Dairy Herd Maintained on the Nevada Test Site January 1, 1976, through December 31, 1976. EMSL-LV-0539-11. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 27 pp. 1978.

Daley, E. M. Agronomic Practices of the Nevada Test Site Experimental Dairy Farm During 1974 through 1977. EMSL-LV-0539-21. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 34 pp. 1978.

Smith, D. D. "Area 13 Grazing Studies--Additional Data." pp. 59-93. Selected Environmental Plutonium Research Reports of the NAEG. NVO-192. M. G. White and P. B. Dunaway, eds. Nevada Applied Ecology Group, U.S. Department of Energy, Las Vegas, Nevada. 2 Vol. 759 pp. 1978.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1975 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-14. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 88 pp. 1978.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1976 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-20. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 111 pp. 1978.

Giles, K. R. A Summer Trapping Method for Mule Deer. EMSL-LV-0539-27. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 5 pp. 1979.

Smith, D. D. Summary Report of the Grazing Studies Conducted on a Plutonium-Contaminated Range in Area 13 of the Nevada Test Site. EMSL-LV-0539-24. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Las Vegas, Nevada. 104 pp. 1979.

Smith, D. D., K. R. Giles, D. E. Bernhardt, A. B. Crockett, and R. R. Kinnison. Animal Investigation Program 1977 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-26. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 90 pp. 1979.

Taylor, W. D. and K. R. Giles. Freshwater Algae of the Nevada Test Site. EMSL-LV-0539-25. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 19 pp. 1979.

Bohman, V. R. and C. Blincoe. The Intake and Digestibility of Range Plants Grown on Plutonium-Contaminated Soils as Determined with Grazing Cattle. EMSL-LV-0539-34. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, Nevada. 43 pp. 1980.

Gears, G. E., G. LaRoche, J. Coble, B. Jaroslow, and D. D. Smith. Investigations of Reported Plant and Animal Health Effects in the Three Mile Island Area. NUREG-0738 and EPA 60C/4-80-049. U.S. Nuclear Regulatory Commission, Office of Nuclear Regulation, Washington, D. C. And U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 33 pp. 1980.

Smith, D. D. Status Report of Area 15 Experimental Dairy Farm: Dairy Husbandry January 1977 - June 1979, Agronomic Practices January 1978 - June 1979. EMSL-LV-0539-32. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 28 pp. 1980.

Smith, D. D., D. E. Bernhardt, and K. R. Giles. Animal Investigation Program 1978 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-80-096 and DOE/DP/0059-038. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 65 pp. 1980.

Blincoe, C., V. R. Bohman, and D. D. Smith. "Ingestion of Plutonium and Americium by Range Cattle." Health Physics 41:285-292. 1981.

Smith, D. D. and V. E. Andrews. Selected Radioisotopes in Animal Tissues in Nevada: ^{90}Sr and ^{137}s Measurements from 1956 to 1977. EPA-600/3-81-027 and DOE/DP/0059-040. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 54 pp. 1981.

Smith, D. D., D. E. Bernhardt and K. R. Giles. Animal Investigation Program 1979 Annual Report: Nevada Test Site and Vicinity. EPA 600/3-81-035 and DOE/DP/0059-042. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 74 pp. 1981.

Smith, D. D. and K. W. Brown. Preliminary Grazing Studies with Rumen-Fistulated Steers at Selected Nuclear-Test Sites. EPA-600/3-81-004. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 32 pp. 1981.

Smith, D. D., D. E. Bernhardt and K. R. Giles. Animal Investigation Program 1980 Annual Report: Nevada Test Site and Vicinity. EPA 600/3-81-077 and DOE/DP/0059-045. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 62 pp. 1982.

Smith, D. D. and S. C. Black. Animal Investigation Program for the Nevada Test Site: 1957 - 1981. EPA/600/6-84-020 and DOE/DP/0539-050. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 75 pp. 1984.

APPENDIX. NTS FARM PROJECTS (chronological order)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Pike	3/13/64	^{131}I	Ingestion; inhalation	3 cows at each of two local farms	24 days	Milk; feed; water; air; soil
Purpose: Study uptake of radioiodine under local dairy farm management conditions. Findings: $T_{1/2}$ of 3.8 days in milk from cows on green chop; $T_{1/2}$ of 5.9 days in milk from cows on hay; peak milk to peak feed ratio of 0.04 to 0.08. Bibliographic references: #1, #48.						
TORY II-C	5/20-25/64	^{131}I	Ingestion; inhalation	2 groups of 4 cows on 4,000-ft arc; 1 group of 4 cows fed green chop	8 hours	Milk; feed; water; air; soil
Purpose: Determine amount of radioiodine that will enter cows' milk from fallout under simulated summer feeding conditions plus inhalation. Findings: No activity detected. Bibliographic references: No report.						
#1	3/10-17/64	^{131}I	Intravenous injection of 1.25 nCi, Na ^{131}I	2 cows	1 injection	Milk
Purpose: Establish techniques for collection of milk samples containing low concentrations of ^{131}I. Findings: Proper collection techniques developed; decontamination procedures, proper labeling, and expeditious handling emphasized. Bibliographic references: No report.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
KIWI	9/28/64	^{131}I	Ingestion	4 cows fed contaminated green chop; 4 control cows	4 days	Milk; feed; water
	10/10/64	^{131}I	Ingestion	10 cows fed contaminated green chop	2 days	Milk; feed; water
	Purpose: Measure amount of radioiodine entering cows milk as a result of fallout under simulated summer feeding conditions. Findings: Insufficient activity for analysis. Bibliographic reference: No report.					
SULKY	12/18/64	^{131}I	Ingestion inhalation	4 cows inhalation; 3 cows ingestion; 8 cows ingestion and inhalation	13 days	Milk; hay; water; soil; vegetation; air; ejecta; blood; precipitation; film badges
	Purpose: Quantify amount of radioiodine excreted in milk of dairy cows fed under simulated winter feeding conditions. Findings: Objectives not achieved as significant amounts of radioactivity not released; however, experience gained in conducting winter field studies with lactating cows. Bibliographic reference: #3.					
TNT	1/12/65	^{131}I ^{133}I	Ingestion	12 cows fed contaminated hay; 4 control cows	6 days	Hay; milk; blood; fallout; air; film badges; soil; vegetation

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: Determine kinetics of uptake and secretion of radioiodine in milk following ingestion of contaminated hay, and determine amount of radioiodines deposited on stacked hay versus loose hay in a fallout location. Findings: Peak values in milk of 830 pCi/l for ^{133}I and 150 pCi/l for ^{133}I; 5.7-day T_e of ^{131}I in milk from cows fed hay from 4,000-ft arc; air sampling indicated contaminant ingested by Group I cows was less gaseous than that for Group II cows; radioiodine in the effluent contaminated the loosely piled hay to a greater extent than stacked hay. Bibliographic references: #6, #48.						
Palanquin	4/14/65	^{131}I	Inhalation; ingestion	4 cows inhalation; 3 cows inhalation and sacrifice; 15 cows ingestion; 4 calves fed contaminated milk	6 fed green chop 4 days; 6 fed hay 8 days; 3 fed hay 24 days; 7 inhalation during cloud passage 2 days	Milk; green chop; tissues; blood; air; vegetation; soil; fallout; film badges; in vivo thyroid
Purpose: To investigate the air-forage-milk chain; determine the relative importance of inhalation of radioiodine; distribution in cow tissues following inhalation; and thyroid uptake in calves fed contaminated milk. Findings: Peak milk ^{131}I concentrations were higher in cows exposed to the effluent than in cows eating contaminated forage; peak ^{131}I milk concentrations appeared in 2-3 days in the cows eating contaminated food, and the peak milk to peak forage ratio was 0.03; tissue distribution studies indicated peak thyroid concentration occurred 76 hours after exposure, that 33.6% of intake was present in the cow 56 hours after exposure, and that the ^{131}I concentrations in fetal thyroids was 2.4 times that of the maternal thyroid. Bibliographic references: #23, #48.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#2 (Milkrun)	8/11/65	^{131}I; ^{126}I	Oral dose of ^{126}I & ^{131}I; milk from dosed cows	4 groups of 2 cows given different ratios of $^{126}/^{131}I$; 4 calves fed milk from each group	cows received dose in capsule in a.m. of 8/11; calves fed milk for 14 days	Milk; blood; hay; grain; water; in vivo thyroid counting

Purpose: Develop techniques to analyze ^{126}I in the presence of ^{131}I in milk; to determine variations in time of ^{126}I - ^{131}I levels in milk from cows given a single dose in various proportions; to determine calf thyroid uptake from ingestion of milk; and to compare AgCl precipitation and ion exchange separation methods with gamma spectrometry.

Findings: Peak milk levels were observed at five hours after dosing; the effective half life in milk averages 14.4 hours; calf thyroid uptake averaged 11.5% with an effective half life of 7.5 days. Recoveries of radioiodine from milk by ion exhange column and AgCl precipitation methods indicated the need for further study prior to field use. ^{126}I can be detected and quantitated in milk in the presence of ^{131}I by determining the physical half-life of the combined radionuclides.

Bibliographic references: #11, #48.

#3 (Hayseed)	10/4/65	^{131}I	Inhalation; ingestion	4 cows inhalation;	30 min	Milk; hay; green chop; sudan grass; grain; water; blood; air; particles; in vivo thyroids
				4 cows fed contaminated hay;	5 days	
				4 cows fed contaminated green chop;	4 days	

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
				4 cows fed contaminated sudan grass; 3 control cows; 6 calves fed milk	5 days	

Purpose: Relate the amounts of ^{131}I tagged dry aerosols deposited on spread hay, spread green chop and growing sudan grass; determine the kinetics of ^{131}I secretion into milk from cows fed these different forages or inhaling the aerosol; develop methods for generating and measuring aerosols.

Findings: The peak average daily milk values to peak average forage values were 0.0078, 0.0063 and 0.027 respectively for fresh green chop, spread green chop and spread hay; approximately 2% of the ingested ^{131}I was secreted in the milk of cows fed spread or fresh green chop and 6.3% for hay fed cows; effective half-life in the fed cows was approximately 2.7 days while in the inhalation cows it was 0.8 days; calf thyroid levels peaked in 7 days and decreased with a T_E of 6 days after feeding stopped.

Bibliographic references: #2, #14, and #48.

#4 (Alfalfa)	6/21/65	^{131}I	Inhalation; ingestion	4 cows inhalation;	30 min	Milk; hay; green chop; grain; water; air particles
				4 cows fed spread hay;	8 days	
				4 cows fed spread green ghop;	4 days	
				4 cows fed fresh green chop;	9 days	
				2 control cows		

Purpose: A repeat of experiment #3 utilizing growing alfalfa-oats, instead of growing sudan grass, and a smaller aerosol.

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: Peak milk levels for inhalation was 2 orders of magnitude less than from ingestion of contaminated forage; greatest amount of ^{131}I aerosol was deposited on forage with the most surface area; ratios of peak average milk to peak average forage concentration were 0.061 for hay, 0.036 for green chop and 0.032 for growing alfalfa-oats; apparently, sudan grass in experiment 3 inhibited milk secretion of ^{131}I. Bibliographic references: #9, #14, and #48.						
#5 (Rainout)	9/29/66	^{131}I	Ingestion	6 cows fed alfalfa hay; 6 cows fed growing alfalfa; 6 control cows	8 days	Milk; hay; green chop; grain; water; particles
Purpose: To mimic passage of a fallout cloud through a rain cloud; determine concentrations of ^{131}I on growing alfalfa and on alfalfa hay as a result of applying ^{131}I as an aqueous solution; determine ^{131}I content in milk from cows fed these forages and to relate concentrations of ^{131}I in forage to that in milk. Findings: Peak activity in milk from cows consuming both types of forage occurred one day after feeding; peak milk to peak forage ratio was 0.013 for hay fed cows and 0.041 for green chop fed cows; hay fed cows secreted in milk 4.5% of amount of ^{131}I ingested, while green chop fed cows secreted 6.1%. Bibliographic references: #16, #48.						
Pinstripe	4/25/66	^{131}I	Inhalation; ingestion	4 cows in Hiko, NV; 6 cows, Alamo, NV	15 days	Milk; vegetation; water; hay; green chop; air

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: To determine amounts of radioiodines in milk from cows under actual farm conditions eating fresh green chop contaminated with fresh fission products; determine the effect of countermeasures in reducing milk levels. Findings: Effective half-life of ^{131}I in milk at two farms from cows eating green chops was 5.5 and 4.0 days; milk-to-forage ratios were 0.86 and 0.078. In one of the herds uncontaminated hay was substituted after the third day. Over an 18 day period this countermeasure reduced the potential thyroid dose of humans consuming one liter of milk per day to 29% of the dose compared to no countermeasure. Bibliographic references: #8, #48.						
#6	Aug. & Sept. 1966	^{134}Cs	Ingestion	4 cows 0.82 kg; 4 cows 0.54 kg; 4 cows 0.27 kg; 4 cows 0 kg verxite daily	23 days 23 days 23 days 23 days	Milk; grain
Purpose: To determine decrease in ^{134}Cs concentration in milk from ingestion of various levels of verxite. Findings: Compared to the zero verxite group, average percent reductions of ^{134}Cs in milk of the 0.82, 0.54 and 0.27 verxite-treated groups were 88, 84 and 68, respectively. There were no significant changes in Na, K, Ca or Mg concentrations in the milk. Bibliographic references: #4.						
#7 (Checkout)	1/20/67	^{50}Cr, ^{59}Fe, ^{187}W	Ingestion	1 cow	Single dose of 80 μCi ^{50}Cr, 45 μCi ^{59}Fe and 608 μCi ^{187}W	Milk

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: Obtain preliminary information on uptake, secretion and metabolism of iostopes of Tungsten, Chromium and Iron. Findings: ^{50}Cr not secreted in milk; ^{59}Fe secreted in trace amounts; ^{187}W was secreted in milk with an effective half-life of 16 hours. Bibliographic references: No report.						
Phoebus	2/23/67	^{131}I	Ingestion; inhalation	11 cows fed contaminated hay; 6 cows inhalation	5 days	Milk; hay; H_2O; grain
Purpose: Measure amount of radioiodine entering cows milk from hay contaminated with reactor effluent and uptake via inhalation of effluent. Findings: Insufficient activity - effluent cloud missed hay stations. Bibliographic references: No report.						
#8 (Sip)	6/6/67	^{131}I	Ingestion; inhalation	6 cows fed hay; 6 cows fed green chop; 6 cows inhalation	1 day 10 days 30 min	Milk; hay; green chop; grain; water; air
Purpose: To measure deposition on growing forage of ^{131}I in a dry aerosol with a CMD <1 μm; measure secretion of ^{131}I in milk of dairy cows under simulated summer feeding conditions, simulated winter feeding conditions and from inhalation only. Findings: Pasture was contaminated to a level of 1.13 μCi/kg; cows fed green chop secreted peak levels of 70 nCi/l in milk; effective half-life of ^{131}I in milk was 5.2 days which was nearly twice that seen in previous studies using aerosol of larger particle size; peak milk to peak forage ratio was 0.06. Bibliographic references: #14, #15, and #48.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#9 (Mice)	9/22/67	^{131}I	Ingestion; inhalation	All cows- inhalation; 6 fed hay; 6 fed green chop; 6 inhalation only; 4 goats fed green chop	30 min aerosol 8 days 8 days	Milk; hay; green chop; grain; water; air

Purpose: Determine deposition velocity and forage retention of molecular iodine; determine milk transfer of ^{131}I after consumption by cows of contaminated forage; compare uptake via ingestion versus inhalation; compare milk transfer parameters of cows vs. goats.

Findings: Deposition velocity of gaseous iodine was much less than that bound to particulates; ingestion of contaminated forage resulted in 80 times as much ^{131}I transfer to milk as inhalation; goats transfer ^{131}I from forage to milk more efficiently, peak milk to peak forage ratios were 0.053 in cows and 0.089 in goats.

Bibliographic references: #7, #14, #46 and #48.

Cabriolet	1/26/68	^{131}I	Ingestion of contaminated hay	4 cows	8 Days	Milk; hay; water; grain; air; fallout particles

Purpose: Obtain correlations between surveillance data and peak milk concentrations for predictions and obtain correlations between filter/charcoal measurements and transfer of radioiodine in the forage-cow-milk system.

Findings: The biological availability of ^{131}I was less than observed previously, less than 3% of ingested ^{131}I appeared in milk and both its T_{eff} and time to peak milk concentrations were longer; peak milk/peak forage ratio was less than 0.01.

Bibliographic references: #22, #48.

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Buggy	3/12/68	^{131}I ^{187}W	Ingestion of contaminated hay	8 cows 8 cows	1 day 8 days	Milk; hay; water; grain; air; fallout particles

Purpose: Same as for Cabriolet except also made comparisons between single and multiple ingestion of hay contaminated at same location.

Findings: Same as for Cabriolet. Multiple ingestion yielded peak milk concentrations 3-5 times that from a single ingestion and the total ^{131}I in milk was 15 times greater. Although ^{187}W concentration in hay was 10 times that of ^{131}I, less than 0.5% appeared in the milk and the T_{eff} was only 2.5 days.

Bibliographic references: #22, #48.

#10, #11	5/7/68 8/13/68	^{131}I	Ingestion	1 cow 3 cows	Single dose Single dose	Milk; feces; urine

Purpose: Provide data to develop mathematical model for accurate prediction of the amount of radioiodine which will appear in milk of dairy cows at specific times after exposure.

Findings: Data used to verify previous findings.

Bibliographic references: No report.

#12 (HARE)	9/18/68	^{131}I	Ingestion	3 cows--sudan green chop; 3 cows--alfalfa green chop; 3 cows--alfalfa green chop and metabolism; 6 control cows	8 days	Milk; green chop; water; air; grain; particles

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements

Purpose: To evaluate the relationship of ^{131}I secretion in milk to the ingestion of different types of contaminated forage and to obtain a further indication of the possible influence on milk radioiodine of changing the particle size of the contaminant.

Findings: Ratios of peak milk activity to peak forage activity was 0.0145 for cows fed alfalfa and 0.0082 for cows fed sudan grass; results of this study indicate major effect on activity level in milk is related to forage type; ingestion of sudan grass reduces transfer of radioiodine to milk by one third compared to ingestion of alfalfa.

Bibliographic references: #40, #48 and #14.

Schooner	12/8/68	^{131}I ^{187}W	Ingestion	14 cows fed contaminated hay from 3 different locations; 5 control cows	10 days	Milk; hay; water; grain; air; particles

Purpose: To determine the amount of radioiodines and ^{187}W deposited on baled hay and secreted in the milk of cows fed this hay; determine the differences, if any, for these isotopes when the cows are fed hay from bales exposed to different portions of the cloud; search for correlations among the gaseous/particulate ratio, integrated air concentration, planchet deposition and exposure rates versus forage contamination, peak milk concentration and effective half-life.

Findings: As in the Cabriolet and Buggy experiments, the biological availability of ^{131}I, ^{133}I and ^{187}W was much reduced compared to previous experiments. Less than 4% of the ^{131}I and less than 0.07% of the ^{187}W ingested by the cows was secreted in their milk. The areal deposition ($\mu Ci/m^2$ on planchets) and the 1-m peak gamma mR/h were useful for predicting the peak concentration in cow's milk. The particulate/gaseous ratio in the debris deposited had some effect on the peak concentration of radioiodine in the milk. The prediction of peak milk concentration from air sampler data was improved if the integrated air concentration was divided by the filter/charcoal activity ratio.

Bibliographic references: #25, #48.

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#12 (Shimoda)	5/13/69	^{123}I ^{131}I	Ingestion	3 cows fed ^{131}I contaminated hay; 1 cow oral dose of ^{131}I; all received ^{123}I orally	3 days	Milk; hay

Purpose: Investigate the feasibility of using ^{123}I as a tracer to determine total uptake of iodine by cows fed hay contaminated with ^{131}I.
Findings: As the ^{123}I was contaminated with ^{124}I, the objective was not met.
Bibliographic references: No report.

#13 (Wolf I)	7/24/69	^{187}W	Ingestion	4 cows maintained in metabolism stall for 4 days	Single dose (1.0 mCi)	Blood; feces; milk; and urine

Purpose: Determine excretion pathways for ^{187}W following single oral administration.
Findings: Within 84 hours 64%, of administered dose was eliminated via feces, 14.6% via urine, and 0.4% in the milk.
Bibliographic references: #49.

#14 (Plum)	8/13/69	^{203}Pb	Ingestion	4 cows in metabolism stall for 5 days	Single (1.5 mCi)	Blood; feces; milk; urine

Purpose: Obtain reliable biological data to assess potential hazard imposed by Plowshare releases of radiolead and to obtain blood, urine, and fecal concentrations in the dairy cow.
Findings: Peak activity appeared in the milk 30 hours following administration of the nuclide and then declined with a half-time of 70 hours. Less than 0.02% of the ingested ^{203}Pb was secreted in milk. Over 91% of the administered dose was recovered in the feces within 84 hours, approximately 0.1% was excreted in urine.
Bibliographic references: #18.

(continued)

APPENDI... (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#15 (Endpoint)	8/27/69	^{131}I	Oral & I.V.	3 cows	Single dose - 0.1 mCi	Tissues and organs
Purpose: Terminal study using unsatisfactory cows to obtain information on the distribution of radioiodine in the major organs and systems of the dairy cow. Findings: None. Bibliographic references: No report.						
#16 (Thallus 1)	9/15/69	^{202}Tl	Oral	4 cows in metabolism stalls; 1 cow sacrifice	Single dose - 0.5 mCi	Milk; urine; feces; blood and tissues
Purpose: Determine uptake, secretion and deposition data on the metabolism of radiothallium following a single oral dose. Findings: Peak activity in the milk occurred in 18 hours; 0.03% of the administered dose was recovered in the milk in 30 days; activity in milk had a 30 hour biological half-life. Bibliographic references: #19.						
#17 (Wolf II)	10/29/69	^{181}W	Oral	4 cows in metabolism stall; 2 calves fed milk and sacrificed; 1 cow and calf sacrificed	2/day for 10 days; 0.05 mCi per dose 4 days	Milk; urine; feces; blood and tissues
Purpose: Investigate the retention, secretion, and distribution of radiotungsten in the dairy cows following multiple oral ingestion, simulating the continued ingestion of contaminated forage and to study the retention of radiotungsten in calves fed milk from these cows.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: The average percent of administered dose secreted per liter of milk at peak activity was 0.01; during the 84-hour period after dosing, 64% recovered in the feces, 14.6% in urine and 0.4% in milk; principal sites of short-term radiotungsten deposition were skin, liver and soft tissue; long-term retention sites in mature cows were bone, muscle and skin and in calves were bone, adrenal, skin and spleen. Bibliographic references: #49.						
#18 (RIMS I)	12/09/69	^{131}I	Oral	4 cows - I_2; 4 cows - CH_3I; 4 cows - NaI; 4 cows - $NaIO_3$	Single oral dose 0.4 mCi	Milk; in vivo thyroid
Purpose: Determine whether the chemical form of ingested radioiodine affects the amount of radioiodine secreted in milk and transferred to the thyroid. Findings: For these 4 chemical forms, the effective half-life in milk was approximately 1 day for the first 5 days; peak thyroid concentration occurred in approximately 2.8 days; ion-exchange analysis indicated that, regardless of chemical form, 97% of the iodine in the milk was inorganic. These results suggest no significant differences in the thyroid uptake and milk transfer among the compounds tested; results of milk and thyroid analysis of a single Jersey cow in the elemental iodine group appeared variant. Bibliographic references: #27.						
#19 (Lightwater I)	12/22/69	^{3}H	Oral	4 cows	Single dose (100 mCi)	Milk; blood
Purpose: Establish the time for tritium to reach equilibrium in the body fluids of the dairy cows; determine the biological half-life of tritium in the milk; and determine the fraction of tritium in the serum, fat and protein portions of milk.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: The tritium content of whole milk decreased as a three component exponential which yielded half-times of 3.04 ± 0.09, 11.1 ± 2.58, and >120 days; study of the milk fractions showed half-times of 2.93 ∓ 0.14 and 43.7 ± 4.28 days for milk serum; 2.08 ± 0.56 and >50 days for milk protein; and 3.28 ± 0.35 and 60.7 ± 43 days for butterfat. Bibliographic references: #50.						
#20 (Thallus II)	1/9/70	^{202}Tl	Oral	4 cows; 2 calves (milk from cows); 1 calf	7 days 11 & 20 days Single Dose (100 mCi)	Milk; blood; tissues
Purpose: To measure the milk, fecal, and urinary excretion of radiothallium following multiple oral ingestion; measure the tissue distribution of radiothallium in calves fed milk from these cows. Findings: Peak activity in milk occurred in 18 hours and was 0.03 percent of the administered dose per liter; biological half-time of thallium-202 in the milk was 22 hours; combined excretion was 25 percent after 36 hours, and 46 percent after 84 hours, with feces preferred route of excretion; about 2.5 percent of the dose secreted in the milk in 30 days. Bibliographic references: #19.						
#21 (RIMS II)	2/10/70	$^{131}I_2$	Oral	3 Jersey cows; 2 Jersey control cows	1 dose $^{131}I_2$ (0.275 mCi)	Milk; in vivo thyroid
Purpose: The milk and thyroid analysis of the Jersey cow in the I_2 group of study #18 (RIMS I) appeared variant, thus a repetition of the $^{131}I_2$ ingestion with that cow plus two additional Jersey cows; control NaI dosing of two Jersey cows.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: Results indicate that the findings for the Jersey cow in study #18 (RIMS I) was an artifact and there were no differences due to breed in the metabolism of radioiodine. Bibliographic references: #27.						
#22 (Wolf III)	3/3/70	^{187}W	I.V.	4 cows in metabolism stalls	Single dose (1 mCi)	Milk; blood; urine; feces
Purpose: To evaluate long-term excretion of radiotungsten; determine any metabolic differences between oral and I.V. dose. Findings: The average percent of dose secreted per liter at peak activity was 0.01 and 0.1 for the groups receiving oral and i.v. doses, respectively; during the 84-hour period after oral dosing, 64% was recovered in the feces, 14.6% in urine and 0.4% in milk; after the intravenous dose, 65% was in urine, 2% in the milk and less than 1% in feces. Bibliographic references: #49.						
#23 (Beryl)	4/27/70	^{7}Be	Oral	4 cows in metabolism stalls; 1 cow & 3 calves sacrificed	Single oral dose of 3.0 mCi	Milk; urine; feces; blood; tissues
Purpose: Investigate the milk transfer and tissue distribution of radioberyllium following a single dosing. Findings: Less than 0.002% of the ingested activity was recovered in the milk; biological half-time in the milk was 19 hours. The liver, kidney and skeletal system accumulate most of the absorbed activity. The bone appeared to be the site of long-term deposition. Bibliographic references: #28.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#24 (Lightwater II)	--	^{3}H	Oral	4 cows; 3 steers	Single (200 mCi)	Blood; milk

Purpose: To determine difference in blood tritium levels between lactating and nonlactating animals and to determine the biological half-life in different milk components.
Findings: Tritium in the blood serum of steers decreased with half-lives of 4.05 ± 0.21 and 40.4 ± 9.82 days which was not significantly different from lactating cows.
Bibliographic references: #50.

#25	--	^{3}H	Oral & inhalation	4 swine	Continuous exposure to gas heater;	Food; gas; urine; air
				4 swine	exposure to gas heater plus food cooked with tritiated gas	

Purpose: Estimate radiation dose which may be received by people as a result of domestic consumption of tritiated natural gas from nuclear stimulation of gas fields.
Findings: Under severely conservative conditions of gas use, the major mode of tritium intake was from inhalation and skin absorption. Extrapolation of experimental data from pigs to a reference man indicates that a continuous natural gas tritium concentration of 1 nCi/l (STP) could result in a radiation dose of about 2 mrad/year.
Bibliographic references: #24, #29.

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#26 (Rubi)	6/15/70	^{86}Rb	Oral	4 cows;	Single oral dose (2 mCi)	Milk; blood; urine; feces, tissues
				1 cow, 3 calves		

Purpose: Establish metabolism of radiorubidium by dairy cows with special emphasis on transfer to milk.

Findings: Maximum concentration of 0.16% of the dose per liter appeared in the milk. The activity decreased with biological half-times of 13 and 84 hours. Half of the ^{86}Rb was excreted in 66 hours, 8% was secreted in the milk, 12% was excreted in the feces, and 30% in the urine. Approximately 75% of the administered activity was eliminated after one week. Deposited activity was highest in the liver, thymus, pancreas, muscle and other soft tissue. Rubidium is readily absorbed by the dairy cow and a substantial portion is transferred to milk.

Bibliographic references: #30.

#27 & #28	7/15/70	^{3}H	Inhalation and skin absorption	3 swine	24 hours	Air; blood; atmospheric moisture
				3 swine	2 hours	
				4 cows	Single oral dose (1.7 mCi)	Milk; urine; feces; blood

Purpose: Evaluation of the hazard to man following an accidental tritium release from rupture of a luminous source material. These studies considered two possible accident conditions, i.e. tube rupture in open air and in a small unventilated room.

Findings: Biological absorption of released tritium in the open air experiment was found to be 0.001%, a 70-fold increase in the biological absorption was observed during the experiment in a tent. Extrapolation to a similar human exposure indicates that the rupture of a 1 Ci source in an enclosure would result in a dose commitment of 230 mrem.

Bibliographic references: #26.

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#29 (Quicksilver)	8/3/70	^{203}Hg	Oral	2 cows; 3 calves	Single oral & i.v. doses	Tissues

Purpose: Study the metabolism and tissue distribution of radiomercury.
Findings: Peak activity appeared in the milk 42 hours after ingestion; biological half-time in milk was 131 hours. In the 10-day period after dosing, 75% of the mercury-203 was excreted, with 0.08% in the urine, 0.01% in the milk, and the remainder in the feces. Radiomercury was distributed throughout the body after both intravenous and oral administrations, with the kidneys being the site of principal concentration.
Bibliographic references: #39.

#30	--	^{131}I	Oral	3 goats; 8 cows	Single dose	Cheese & milk

Purpose: The transfer of radioiodine to cheese from contaminated goat and cow milk was evaluated. The study compared the transfer of radioiodine from *in vivo* and *in vitro* labelled milk to cheese.
Findings: The *in vivo* goat data indicate a transfer of 7.9% of the activity in the milk to the cheese the *in vitro* values were 6.2%. The Holstein *in vivo* and *in vitro* experiment resulted in 11.0% transfer. The *in vivo* transfer for Jersey cows was 17.7% and the *in vitro*, 15%.
Bibliographic references: #17.

#31 (Washout)	9/29/70	^{131}I	Inhalation and ingestion of contaminated feed	2 groups of 4 cows	8 days	Milk; green chop; air; water; grain

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: To study, under controlled conditions, the efficiency of the washout process for removal of particulate and gaseous ^{131}I aerosols from air by rain. Also, to study the peak milk to peak forage ratio of ^{131}I for groups of cows fed washout contaminated or dry aerosol contaminated green chop. Findings: Little enhanced forage activity by washed out particulates. 100% increase in forage activity by washout of gaseous iodine. No significant difference in milk to forage ratio for the two types of contaminant. Bibliographic references: #48.						
#32 (Ferric)	10/19/70	^{59}Fe	Oral; intravenous	4 cows 1 cow	Single dose (2.4 mCi)	Milk; urine; feces; blood
Purpose: Estabish milk transfer and investigate the metabolism of ^{59}Fe in dairy cows following a single dose. Findings: A peak activity concentration of 0.00018% per liter appeared in the milk 51 hours after oral administration and decreased with a biological half-life of 172 hours. Fifty percent was eliminated in 30 hours and more than 99% of that was in feces. Less than 0.015% of the nuclide was secreted in milk in 10 days. The peak activity concentration in milk of 0.026% per liter occurred 33 hours after i.v. administration and decreased with a biological half-life of 84 hours followed by one of 180 hours. Bibliographic references: #19.						
#33 (Baneberry)	12/18/70	^{131}I, ^{3}H	Inhalation plus ingestion	4 cows 6 cows	5 days 10 days	Milk; hay; water; grain
Purpose: Document the relative importance of inhalation vis-a-vis ingestion in the transfer of radioiodine to milk during venting from an underground test.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: T_{eff} was about 33 hours for cows. Peak activity in milk occurred in 48 hours. Peak milk to peak forage concentration ranged from 0.1-0.5. Forage fed inhalation cows was also found to be contaminated hence all groups were exposed by inhalation and ingestion.						
#33 (Baneberry)	12/18/70	Fission products	Inhalation plus ingestion	2 calves	96 hours	Tissues
Purpose: Determine tissue distribution of fresh fallout. Findings: The highest levels of gamma-emitting radionuclides were detected on the hair of the calves. The thyroids contained significant levels of ^{133}I and ^{131}I (0.73 & 0.78 nCi/g). The activity in the lungs was relatively low, with no detectable gamma-emitting radionuclides reported on recount. Tritium concentrations in the urine of both calves were found to be 1.9 pCi/ml.						
#33 (Baneberry)	4/14 - 7/21/71	^{3}H fission products	Ingestion	Rumen fistulated steers	Contaminated forage 72 hours every 3 weeks	Blood and rumen contents
Purpose: Determine oral intake of cattle grazing natural vegetation. Type of forage and contamination measured in rumen contents. Findings: The tritium levels in the blood of the fistulated steers were higher following grazing and were slightly higher than that found in the rumen contents. Short-lived radionuclides detected included ^{103}Ru, ^{95}Zr, and ^{124}Sb. Bibliographic references: #42.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
#34	12/20/70	^{131}I	Deposition	Grayia spinosa	Fallout cloud passage	Plants & planchets
Purpose: To determine if plants can be used in the absence of mechanical samplers to give information about the release of radioactive particulates from a venting nuclear detonation. Findings: In the absence of man-made collection systems, plants (even dormant) can provide information about release of fallout materials. In the absence of snow, plants were shown to be an important and cheap sample collector. Bibliographic references: #31.						
#35 (Takeup & Retake)	1969	^{131}I	Gaseous and particulate aerosols	Alfalfa	30 minutes	Alfalfa
Purpose: Determine the role of binding and the effective half-life for three different artificial ^{131}I contaminants on growing vegetation. Findings: A fraction of the ^{131}I can be removed by washing with detergent solution but the plants would have to be "cleaned" during a very short period of time following contamination. The retention on alfalfa appears to be particle size dependent only during early time periods. The elemental ^{131}I contaminant showed essentially no rapid early loss and decayed with the physical decay rate. Bibliographic references: #35, #13.						
#36	1970	^{131}I	Injection	Artificial rumen	1 day	Artifical rumen; abomasum; intestinal juice

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: Assess the possibility that ^{131}Iodide might be converted to volatile iodine or methyliodide in rumen juice which could then be inhaled by the cow. Findings: Under the conditions of the study, ^{131}I was not volatile. As much as 3% of the ^{131}I was shown to be associated with rumen juice sediment in the artificial rumen. This value was reduced to 0.52% and 0.038% in the simulated abomasal and intestinal fluids, respectively. Bibliographic references: #33.						
#37 (Tellus)	4/26/71	^{129m}Te	Oral	4 cows 3 calves	Single dose 2.2 mCi 0.5 mCi	Milk; urine; feces; tissue
Purpose: To determine the tissue distribution, retention, and milk secretion of radiotellurium by dairy cows, and the concentration of radiotellurium in the tissues of calves. Findings: The highest concentration of ^{129m}Te in the milk was 0.0035%/L 18 hours following administration. The activity decreased with a biological half-time in the milk of 38 hours. Only 0.254% of the administered nuclide was secreted in milk in 13 days. Thirty hours after dosing 49% of the activity had been excreted by all routes. After 5 days 80% of the activity had been recovered with 95% of this in the feces. The radiotellurium was found to be distributed throughout the body of calves with the main concentration occurring in the kidney and liver. Bibliographic references: #36.						
#38 & #39 (Pu-1 & Pu-2)	5/17/72 4/26/73	^{238}Pu	Oral	4 cows 4 cows	Single dose 3 mCi 19 days at 1 mCi daily	Milk; urine; feces; tissues
Purpose: To obtain information on the significance of milk as a source of plutonium exposure and to gain additional information on plutonium patterns in ruminants. Both plutonium citrate and plutonium dioxide were studied.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: From 96% to almost 100% plutonium activity was excreted in the feces. Activity in urine and milk following both the acute dose of plutonium citrate and the multiple doses of plutonium dioxide confirmed the bovine gastrointestinal uptake. In both groups, the total deposition of plutonium was greatest in bone, liver, and skeletal muscle. Plutonium was also observed to be transported across the bovine placenta. Bibliographic references: #37.						
#40	1973	^{238}Pu ^{241}Am	Ingestion	20 hens 20 hens 20 hens	Daily dose for 14 days- 1 μCi ^{238}Pu citrate; 1 μCi ^{238}Pu dioxide; 2 μCi ^{241}Am citrate	Eggs; tissues
Purpose: To study the metabolism of plutonium and americium by chickens (Gallus domesticus) and its subsequent transfer to eggs. Findings: Yolk was the only egg fraction in which radioactivity was observed regardless of the nuclide administered. The plutonium per yolk tended to plateau after 6 days with the oxide form and after 11 days with the citrate. The americium-241 activity in yolks peaked on the 14th day of dosing. Little plutonium-238 was concentrated in the tissues of hens receiving either form. Americium was detected in most tissues with the main concentration in the liver and skeleton. Bibliographic references: #43.						
#41 (Pass)	11/10/73	^{141}Ce; ^{85}Sr; ^{54}Mn; ^{46}Sc	Ingestion of 4 sizes of sand	4 cows	1 dose	Urine, blood; milk; feces

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: To obtain information on the gastrointestinal passage rates for various soil particle sizes. Findings: The smallest particles (15-25 μm) were excreted rapidly, 90% within 91 hours of dosing. The three larger size particle groups were excreted more slowly and with large variations, up to 288 hours required to excrete 90%. This period would provide more time for gastrointestinal absorption. Bibliographic references: #47, #45.						
#42	1973	^{203}Hg	Aqueous solution applied to soil	Soil	Single	Soil
Purpose: To determine if inorganic mercury can be methylated by terrestrial microorganisms. Findings: Mercuric salts can, under agricultural conditions, be transformed into methylmercury. Mercury deposited in soil is more readily available to humans and animals and the health hazard magnified by the higher toxicity of methylmercury. Bibliographic references: #34.						
	1973	^{203}Hg	--	--	--	Soil
Purpose: To develop an in situ soil gamma analyzer to study the behavior and movement of mercury in soils. Findings: The in situ soil gamma analyzer proved to be an effective and efficient instrument for analyzing pollutant movement in soil. Bibliographic references: #60.						
#43 (Salt Study)	1974	NaCl	Ingestion	9 Hereford heifers	18 weeks	Hay; grain; urine; feces; blood; carcass

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: Determine whether excretion of salts in cattle wastes might be significantly reduced by varying the concentration of added salt in their ration without affecting weight gain. Findings: No difference in health in three groups. Group receiving 0.25% added NaCl gained the best. Salt addition to feed can be reduced without affecting health or weight gain. Bibliographic references: #41.						
#44	1974	^{238}Pu		Aspergillus niger	33 days	Spores; culture media
Purpose: To determine the effects of the pH of the culture media and of the chemical form of plutonium on the uptake of this radionuclide by Aspergillus niger. Findings: ^{238}Pu was taken up from all three chemical forms and transported to the aerial spores of Aspergillus niger at each concentration and at both pH levels. The specific activities of the spores grown at pH 5.5 were at least twice those grown at pH 2.5. The uptake of plutonium from the dioxide form was about one-third of that from the nitrate and citrate forms. Bibliographic references: #44.						
#45 - #46 (Pu-3 & Pu-4)	April-May 75; Nov-Dec 75	^{238}Pu	Intravenous milk	2 cows 4 calves	5 days 6 days	Milk; blood; urine; feces; tissue
			Intravenous in vivo milk	4 cows 12 calves	Single dose 7 days	
			In vitro milk	6 calves	7 days	
Purpose: A two-phase experiment was conducted to determine whether in vivo plutonium-labeled milk presents the nuclide in a more biologically available form than in preparations typically administered for intestinal uptake studies.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: Approximately 1.5% of i.v. dose recovered in milk in 120 hours. Thirty-three % of dose was in liver & approximately 5% in muscle. In individual calf tissues, no discernible differences were detected in nuclide availability between in vivo milk and in vitro labelled milk. Retention in both groups was greater than that previously reported for adult animals. Bibliographic references: #51, #52, #54.						
#47 & #48 (Curium)	1976	^{243}Cu	Oral & i.v. Oral & i.v.	6 goats 2 cows	Single dose Single dose	Milk; urine; feces; blood; tissues
Purpose: To establish the gastrointestinal uptake of curium; determine the amount transported to milk; examine the plasma clearance rate; quantify the excretion characteristics; and establish the tissue deposition pattern in dairy animals. Findings: Gastrointestinal uptake of curium was estimated to be 0.02 and 0.006 percent of the oral dose for cows and goats, respectively. The cumulative percentage of oral dose transported to milk and urine was 4.6×10^{-4} and 1.9×10^{-3}, respectively, for a cow and 2.7×10^{-4} and 1.6×10^{-4}, respectively, for goats. Plasma concentrations of curium decreased rapidly following all i.v. injections. The average percentage of injected curium transferred to milk, urine, and feces was 2, 8, and 1 percent for a cow and 2, 5, and 5 percent for goats. Bovine bone retained the greatest fraction of the administered dose followed by the liver. However, in all three intravenously dosed goats the liver contained the greatest amount of curium. Bibliographic references: #53, #57.						
# 49	1976	^{239}Pu & ^{241}Am	Plants grown in contaminated soil	Alfalfa; radishes; wheat; rye; tomatoes	52-237 days	Soil; stems; leafs, fruiting structures

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Purpose: To determine the extent and magnitude of plutonium-239 and americium-241 assimilation by plants from soils; obtain data on the differences in plant uptake between plutonium-238 and plutonium-239 oxides. Findings: Plutonium incorporation by alfalfa, concentration ratio of 2.5×10^{-6}, was similar to reported data using other chemical forms; differences in the biological availability of plutonium isotopes do exist. Americium-241 was assimilated and translocated to the stem, leaf, and fruiting structures. The concentration ratios varied from 0.001 for the wheat grass to 0.015 for the radishes. The predominant factor in plutonium and americium uptake by plants may involve the chelation of these elements in soils. Bibliographic references: #56.						
#50	1977	^{234}Np	Oral; intravenous	2 goats 1 goat	Single dose Single dose	Milk; urine; feces; tissues
Purpose: To determine milk secretion, metabolism and tissue distribution of neptunium. Findings: From oral and i.v. dosing respectively: in milk 0.01 and 0.24%, in urine 0.42 and 21%, and in feces 97.4 and 2.2%. In tissues, liver and bone had greatest concentration after oral, and bone and liver in that order, after intravenous dosing. Bibliographic references: #59.						
#51 & #52 (Americium)	2/28-3/10/77; 3/30-4/13/77	^{241}Am	Intravenous and oral	2 cows (oral) 2 cows (i.v.) 2 goats (oral) 2 goats (i.v.) 1 goat control	Single dose Single dose	Milk; urine; blood; feces; tissue
Purpose: To establish the gastrointestinal uptake of americium and the amount of activity transported to milk; examine the plasma clearance rate; quantify the excretion characteristics; and establish the tissue deposition pattern in dairy animals.						

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements
Findings: Gastrointestinal uptake of americium by both cows and goats was estimated to be 0.014 percent of the respective oral doses. The cumulative percentage of oral dose transported to milk and urine was less than 2×10^{-3} for cows and less than 5×10^{-3} for goats. The average percentage of injected americium transferred to milk, urine and feces was 3, 6 and 2 percent respectively for cows and 2, 4 and 2 percent respectively for goats. Approximately 30 percent of all americium released from the body was found in the urine during the first 24 hours after injection. Bovine bone retained the greatest fraction of the administered dose followed by the liver. Liver retained the greatest amount of americium in the goats. Bibliographic references: #55.						
#53	11/14/77 11/22/77	^{238}Pu, ^{239}Pu	Oral	4 cows	Single dose	Blood; urine; milk; tissues
Purpose: To determine the relative gastrointestinal absorption and tissue distribution of plutonium-238 and plutonium-239 following oral ingestion of dioxide mixtures by dairy cows. Findings: Results indicate that, when the two isotopes of plutonium are homogenous within the particles, there is no difference between plutonium-238 and plutonium-239 in the relative gastrointestinal absorption and tissue distribution. Bibliographic references: #58.						
#54	Jun-Oct 78	^{241}Am; ^{137}Cs; ^{60}Co; ^{238}Pu; ^{239}Pu; T; and ^{90}Sr	Oral - fed contaminated soil	8 goats	90 days	Blood; feces; grain; soil; tissue

(continued)

APPENDIX. (Continued)

Experiment Name or No.	Date	Isotope	Mode of Exposure	Type and No. of Subjects	Duration	Measurements

Purpose: Determine intestinal absorbtion of radionuclides present in soil ingested by goats and to determine the tissue concentrations of those radionuclides.

Findings: Aged radionuclides are biologically available and gastrointestinal uptake occurs. Strontium-90 was the most readily available with one to eight percent of the dose deposited in the bone. Cobalt-60 and 137-Cs were also readily detected in most of the organs sampled. The transuranics were detected to a much lesser extent. The juvenile animals showed the highest concentration of most isotopes.

Bibliographic references: #60.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. DOE/DP0539-052	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE NEVADA TEST SITE EXPERIMENTAL FARM: Summary Report 1963 - 1981	5. REPORT DATE July 1984
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Stuart C. Black and Donald D. Smith	8. PERFORMING ORGANIZATION REPORT NO. EPA 600/4-84-066
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring Systems Laboratory Office of Monitoring Systems and Quality Assurance U.S. Environmental Protection Agency P.O. Box 15027, Las Vegas, NV 89114	10. PROGRAM ELEMENT NO. XLUF10 11. CONTRACT/GRANT NO. IAG DE-AI08-76DP00539
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy Nevada Operations Office P.O. Box 14100 Las Vegas, NV 89114	13. TYPE OF REPORT AND PERIOD COVERED Response Report, 1963 - 1981 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared for the U.S. Department of Energy under Interagency Agreement Number DE-AI08-76DP00539.

16. ABSTRACT

This report summarizes the findings from experiments conducted at the Experimental Dairy Farm located on the Nevada Test Site. These experiments included the air-forage-cow-milk transport of the radioiodines, and the metabolism and milk transfer of other fission products and several actinides. Major studies are listed in chronological order from 1964 to 1978 and include the purpose, procedures, isotopes used, and findings for each such study. Animal exposures occurred from fallout, from artificial aerosol generation, and from oral or intravenous administration. A complete bibliography and references to published reports of the experiments are included.

The findings from the radioisotope studies at the Experimental Dairy Farm and the results obtained from the Animal Investigation Program provide a rationale for making predictions and for planning protective actions that could be useful in emergency response to accidental contaminating events where fresh fission products are involved.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO THE PUBLIC	19. SECURITY CLASS (This Report) UNCLASSIFIED 20. SECURITY CLASS (This page) UNCLASSIFIED	21. NO. OF PAGES 66 22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE